



# Commodity Price Volatility, Democracy and Economic Growth

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# Commodity Price Volatility, Democracy and Economic Growth

## Abstract

We use a new dataset on non-resource GDP to examine the impact of commodity price volatility on economic growth in a panel of up to 158 countries during the period 1970-2007. Our main finding is that commodity price volatility leads to a significant increase in non-resource GDP growth in democracies, but to no significant increase in autocracies. To explain this result, we show that increased commodity price volatility leads to a statistically significant and quantitatively large increase in net national saving in democracies. In autocracies, on the other hand, net national saving decreased significantly. Our results hold true when using indicators capturing the quality of economic institutions in lieu of indicators of political institutions.

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## 1. Introduction

Volatile terms of trade pose serious macroeconomic challenges to developing countries. In this paper, we focus on the effects that commodity price volatility may have on economic growth in commodity-exporting countries. Figure 1 shows that over the past decades the volatility associated with various international commodity price indices is far greater than the volatility associated with manufactured product price indices.<sup>1</sup> This evidence suggests that countries that specialize in raw commodity exports face much greater macroeconomic volatility than countries specializing in the export of manufactured products. The presence of volatility may complicate saving/investment decisions by governments, firms and households and, in turn, affect long-run economic performance in commodity-exporting countries. For instance, increased volatility in government revenue may call for higher levels of precautionary saving.<sup>2</sup> Because revenues derived from natural resources transit directly to the government coffers (e.g., through state ownership, taxation or export tariffs), they may be prone to rent-seeking behavior and thus end up not being saved or invested appropriately. In that context, institutions which may prevent misappropriation of natural resources and promote good policies may also play a crucial role in moderating the impact of volatility on economic growth in commodity exporting countries. In this paper, we examine the impact of commodity price volatility on economic growth and net national saving using a new dataset on non-resource GDP in a panel of up to 158 countries during the period 1970-2007.<sup>3</sup>

This paper aims to make two main contributions. First, unlike previous studies, the paper specifically focuses on volatility stemming from commodity price fluctuations at an infra-annual frequency. Indeed, when considering annual averages, one finds that the crude oil price has

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<sup>1</sup> This holds true when considering manufactured price indices for US imports and exports.

<sup>2</sup> This is especially the case in the presence of incomplete markets that may incapacitate governments in commodity-exporting countries trying to hedge against volatility using financial instruments.

<sup>3</sup> Our goal here is to assess the impact of volatility on saving broadly understood and not necessarily from a perspective of evaluating sustainability. We thus use overall saving rather than genuine saving (saving net of resource depletion). In addition, the Hartwick rule (setting genuine saving equal to zero, see Hartwick, 1977) is a commonly used benchmark but could be seen as too restrictive. Indeed, it fails to take into account the potential yield on the investments made out of “rent savings.” If these are high, there can be considerable consumption out of rents on a sustainable basis.

increased by 36 percent between 2007 and 2008.<sup>4</sup> However, when considering monthly averages, one finds that the crude oil price has decreased by 69 percent between July and December 2008. This suggests that the frequency at which the fluctuations in commodity prices are observed reflects very different realities worth pondering when investigating the economic impact of those fluctuations. From a policy perspective, it is, for instance, crucial for the government to consider the monthly changes in government revenues for liquidity management purposes rather than the average yearly changes in revenues (which are certainly more relevant for annual budget planning). Also, monetary authorities in commodity-exporting countries need to consider fluctuations in commodity prices at an infra-annual frequency to be able to conduct appropriate monetary and exchange rate policies. Second, the paper focuses on the effect of commodity price volatility on the non-resource sector. To do so, we use a new dataset on non-resource GDP allowing us to avoid the “noise” introduced by the resource sector’s contribution to overall GDP.<sup>5</sup> Indeed, separating the resource sector’s contribution from overall GDP allows us to examine the externality that the resource sector activity exercises on the non-resource sector’s long-run productivity. From a policy perspective, non-resource-sector GDP should be the relevant measure to be used when assessing the long-run economic viability of an economy whose natural resources have been depleted.

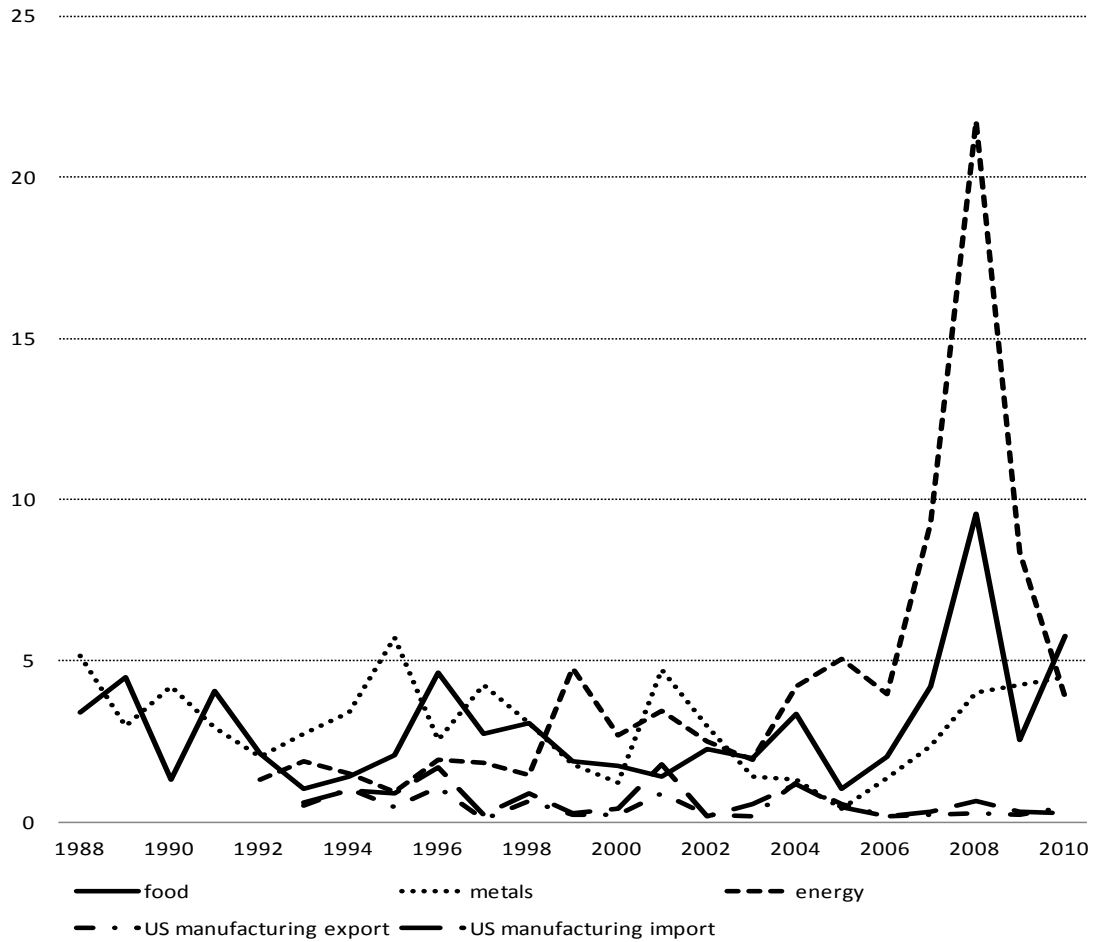
Our main finding is that increased commodity price volatility leads to a significant increase in non-resource GDP growth in democracies, but to no significant increase in growth in autocracies. To explain this result, we show that increased commodity price volatility leads to a statistically significant and quantitatively large increase in net national saving in democracies. In autocracies, on the other hand, net national saving decreased significantly. Our results hold true when using indicators capturing the quality of economic institutions in lieu of indicators of political institutions.

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<sup>4</sup> The crude oil (petroleum) price used is a simple average of three spot prices: Dated Brent, West Texas Intermediate and the Dubai Fateh, US\$ per barrel, available from IMF (2011).

<sup>5</sup> Section 2 describes the estimation of non-resource GDP which takes into account the depletion of the stock of natural resources.

Figure 1. Volatility of Commodity and Manufactured Product Indices



Source: US Bureau of Labor Statistics (2011), IMF (2011) and the authors' own calculations. The volatility is measured by the annual standard deviation of monthly price indices deflated by the US CPI index.

This paper is related to the literature on macroeconomic volatility. Drawing on several of their earlier papers, Aghion and Banerjee (2005) explore the various causal connections between the trend growth of output and the volatility of output around the trend, concluding from empirical cross-country evidence that volatility hurts growth. Along similar lines, Ramey and Ramey (1995) provide evidence that volatility in economic growth diminishes average growth in a sample of 92 countries as well as in a sample of OECD countries. Even so, Gylfason et al. (2010, Ch. 4) demonstrate that significantly reduced output volatility from earlier times to the post World War II period in several industrial countries including the United States, Canada, France, Germany and the Nordic countries was accompanied by virtually unchanged average long-run growth everywhere.

Building on Ramey and Ramey (1995), Mobarak (2005) finds that more democracy leads to lower volatility and more volatility reduces growth using simultaneous equation estimation method. He concludes that the volatility channel is crucial to understanding how democracy affects growth. Similarly, our paper provides empirical evidence that democracy moderates the effect of volatility originating from (plausibly exogenous) fluctuations in international commodity prices on economic growth.

This paper also relates to the literature stressing the importance of political institutions for improving policy outcomes (see, e.g., Persson, 2002). In their seminal contribution to the growth and institutions literature, Acemoglu et al. (2001, 2002) show that political institutions are key determinants of long-run economic development.

Further, this paper relates more directly to the literature on the so-called “resource curse,” focusing specifically on the effects of natural resource endowments on the economic performance of commodity-exporting countries. This literature emphasizes several channels through which resource windfalls may affect economic performance, including the “Dutch disease” and deteriorating institutions, to name a few (for a survey, see Frankel, 2011). This paper departs from the traditional Dutch-disease literature’s distinction between tradable and non-tradable sectors by focusing instead on the distinction between the resource and non-resource sectors. Overall, there is some evidence, albeit somewhat controversial, that commodity-exporting countries tend to grow less rapidly than non-commodity-exporting countries. Sachs and Warner (1995, 2001), Auty (2001) and Gylfason (2001) provided early evidence of a significant negative correlation between natural resource abundance and economic growth. In contrast, Alexeev and Conrad (2009) take a more skeptical view of the resource curse. Using traditional cross-sectional growth regressions, Alexeev and Conrad (2009) find that the empirical association between resource dependence and economic performance is not robust to using samples with different starting years or to the inclusion of

additional controls, but they leave initial income out of their regressions, thus omitting conditional convergence, a crucial growth mechanism, from consideration. Our paper contributes to this literature by focusing on the volatility channel of the resource curse using data on non-resource-sector GDP growth.

The remainder of this paper is organized as follows. Section 2 describes the data. Section 3 presents the estimation strategy and main results. Section 4 discusses a number of robustness checks. Section 5 summarizes our main findings.

## **2. Data**

### **2.1. Non-resource GDP (NRGDP)**

Non-resource GDP is approximated by subtracting the real value of natural resource rents from total GDP in 2005 PPP-adjusted USD (see Hamilton and Ruta, 2008, for details on the computation of resource rents).<sup>6</sup> Natural resources give rise to rents because they are not produced; in contrast, for produced goods and services competitive forces will expand supply until economic profits are driven to zero. An economic rent represents an excess return to a given factor of production. For each type of resource and each country, unit resource rents are thereby derived by taking the difference between world prices (to reflect the social opportunity cost of resource extraction) and the average unit extraction or harvest costs (including a “normal” return on capital). Unit rents are then multiplied by the physical quantity extracted or harvested to arrive at total rent.<sup>7</sup>

### **2.2. Commodity Price Index and Volatility**

We use a country-specific and plausibly exogenous commodity price index. The index consists of a geometric average of international prices of various commodities using (time-invariant) weights

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<sup>6</sup> The data on resource rents are taken from WDI (2011). The GDP data are from Heston et al. (2009).

<sup>7</sup> The energy resources include oil, natural gas and coal, while metals and minerals include bauxite, copper, gold, iron ore, lead, nickel, phosphate, silver, tin and zinc.

based on the average value of exports of each commodity in the GDP for a given country. Annual international commodity price data cover the years 1970-2007 and are taken from UNCTAD Commodity Statistics, while our data on the value of commodity exports come from the NBER-United Nations Trade Database. Because the time-series behavior of many international commodity prices is highly persistent, commodity price shocks are identified by the (log) change in the international commodity price.<sup>8</sup> Our measure of volatility is the annual standard deviation of monthly changes in our commodity price index. The correlation between the log change in our commodity price index and its standard deviation is rather low and negative (-0.14). This suggests that the information contained in these two statistics is quite different and both statistics are worthy of use separately in our empirical analysis.

### **2.3. Democracy**

Democracy is measured by the revised combined Polity score (Polity2) of the Polity IV database (Marshall and Jaggers, 2009). The classification uses a 10-point scale that categorizes four attributes of political systems: the competitiveness of political participation, the competitiveness of executive recruitment, the openness of executive recruitment and the constraints on the chief executive. At one end of the scale, +10, are the most politically competitive and open democracies. At the other, -10, are the least open and competitive autocracies. Following Persson and Tabellini (2003, 2006) and the Polity IV project, we classify countries as democracies (autocracies) if their Polity2 score is strictly positive (negative).

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<sup>8</sup> The commodities included in the commodity export price index are aluminum, beef, coffee, cocoa, copper, cotton, gold, iron, maize, oil, rice, rubber, sugar, tea, tobacco, wheat, and wood. In case there were multiple prices listed for the same commodity a simple arithmetic price average was used.



### **3. Empirical Results**

#### **3.1. Estimation Strategy**

To examine the effects of commodity price volatility on long-run per capita economic growth, we estimate the following dynamic econometric model:

Table 1. Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
$\Delta$ Log NRGDP per capita	1392	0.016	0.046	-0.427	0.353
Initial log NRGDP	1208	8.505	1.139	5.551	11.259
$\Delta$ log Commodity Price Index	1504	0.000	0.003	-0.012	0.027
Volatility	1050	0.053	0.084	0.000	0.717
Diversification	1060	0.170	0.199	0.004	1.000
Credit	1156	37.967	35.758	0.000	276.120
Trade	1214	79.013	43.391	7.210	423.800
Saving	981	9.897	11.763	-38.492	167.130

### 3.2. Economic Growth

The statistical results are presented in Table 2.<sup>13</sup> Our results suggest that the average marginal effect of commodity price volatility on NRGDP growth is both statistically and economically significant. Indeed, we find that an increase in commodity price volatility by one standard deviation leads to an increase in NRGDP growth by slightly less than a third of a standard deviation, as shown in column (3). This result contradicts the view that volatility is harmful for economic growth in commodity-exporting countries. However, the coefficient on volatility is no longer significant when we do not control for the annual change in our commodity price index, as shown in column (1).

<sup>13</sup> First-order and second-order serial correlation tests and the Hansen test on over-identifying moment conditions (not reported in the tables) indicate that the estimated models are correctly specified.

Table 2. Commodity Price Volatility and NR GDP Growth

	All Countries			Autocracies			Democracies		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Initial log NRGDP	-0.0643** (0.0295)	-0.110*** (0.0406)	-0.0682** (0.0310)	0.00578 (0.0257)	-0.0239 (0.0301)	0.00004 (0.0263)	-0.0822** (0.0402)	-0.0715* (0.0410)	-0.0375 (0.0438)
Volatility	0.0782 (0.0604)		0.153*** (0.0554)	-0.0448 (0.0752)		0.0188 (0.0704)	0.162** (0.0732)		0.277*** (0.0846)
$\Delta$ log Commodity Price Index		2.740* (1.510)	3.891** (1.533)		-2.349 (2.048)	-2.316 (2.186)		3.387* (1.909)	6.435** (2.745)
Diversification	0.0101 (0.0529)	-0.113 (0.0696)	-0.0864 (0.0660)	0.116 (0.0814)	0.0397 (0.0952)	0.0983 (0.111)	-0.0179 (0.0552)	-0.0926 (0.0583)	-0.0666 (0.0593)
Credit	0.000562 (0.000388)	0.00142** (0.000583)	0.000661 (0.000406)	-0.000198 (0.000418)	-0.000209 (0.000556)	-0.000460 (0.000423)	0.000665 (0.000470)	0.000769 (0.000502)	0.000216 (0.000496)
Trade	0.000698*** (0.000189)	0.000474 (0.000301)	0.000477** (0.000218)	0.000731** (0.000363)	0.00145*** (0.000366)	0.00122*** (0.000330)	0.000565*** (0.000186)	0.000490* (0.000264)	0.000145 (0.000259)
Number of observations	555	555	555	197	197	197	357	357	357
Number of countries	150	150	150	61	61	61	88	88	88

Note: The dependent variable is  $\Delta$  Log NRGDP per capita. The method of estimation is system-GMM (Blundell and Bond, 1998). Standard errors are shown in parentheses below the point estimates. \*Significantly different from zero at 90 percent confidence, \*\* 95 percent confidence, \*\*\* 99 percent confidence. Fixed effects are included but not reported.

We find that changes in our commodity price index and trade openness have a positive and statistically significant impact on NRGDP growth. Export diversification and financial development have no statistically significant effect on NRGDP growth but are, nonetheless, useful control variables. The significance and sign of those latter results should, however, be taken with caution as they might be plagued by endogeneity. This is less so the case for our measure of volatility in commodity prices as it is based on a plausibly exogenous source of fluctuations, namely, international commodity prices. Indeed, it is reasonable to assume that changes in domestic conditions or, more specifically, changes in the non-resource sector in the countries included in our sample do not affect international commodity prices.

When restricting our sample to autocracies, we find that commodity price volatility does not have a statistically significant effect on NRGDP growth, as shown in columns (4) and (6). It should also be noted that a change in commodity prices has a negative though not statistically significant effect on NRGDP growth, as shown in columns (5) and (6). The negative sign associated with the change in commodity prices echoes the results pertaining to the resource curse hypothesis

suggesting that ample resource endowments weaken economic performance. When restricting our sample to democracies, however, we find that volatility has a statistically and economically significant effect on NRGDP growth, as shown in columns (7) and (9).<sup>14</sup> Using estimates from column (9), we find that an increase by one standard deviation in volatility leads to an increase by more than half a standard deviation in NRGDP growth. This effect is much larger than in our overall sample. This result could suggest that democracies have overcome the challenges posed by increased volatility by adopting policies that promote growth. In the following sub-section, we provide some evidence that the saving channel can help explain why more volatility may lead to more rapid economic growth in commodity-exporting countries. Indeed, higher saving could help shelter commodity-exporting countries from shortfalls in government revenue, help finance or guarantee domestic private investments and also guard those countries against hasty spending programs, including excessively large and wasteful public spending.

By contrast, more volatility – resource booms, in particular – may impede economic growth in autocracies. When national wealth is stored largely in a natural resource, renewable or not, a more common occurrence in autocracies than in democracies, there is less need for financial intermediation to conduct day-to-day transactions. Dissaving at the macroeconomic level can take place through more rapid depletion of the resource and saving can take place through less rapid depletion, or of more rapid renewal in the case of renewable natural resources. In some countries, such as the oil-rich OPEC states, saving also takes the form of deposits in foreign banks. In this case, domestic financial intermediation becomes even less important. In contrast, when saving is piled up at home in the form of physical capital, or human capital, domestic banks and equity markets assume paramount importance. By linking up domestic savers and investors, the domestic financial system contributes to a more efficient allocation of capital across sectors and firms, a

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<sup>14</sup> We also find that increases in the commodity price index lead to a statistically significant increase in NRGDP growth. Those results are broadly in line with those of Melhum et al. (2006) who provide some evidence that good economic institutions can alleviate the resource curse.

growth benefit more commonly absent from autocracies than from democracies.

Not only is it thus possible for recurrent commodity booms associated with abundant natural resources to hamper the development of the financial system and hence to distort the allocation of capital but economic growth may slow down due to the detrimental effect of financial backwardness on the quantity and quality of saving and investment. King and Levine (1993a, 1993b) find that indicators of financial development and their predetermined components predict subsequent growth, physical capital accumulation and improvements in the efficiency of capital allocation.<sup>15</sup> Hence, our hypothesis that natural resource dependence tends to go along with an underdeveloped financial system means, if King and Levine are right, that resource dependence also tends to hinder future gains in efficient capital deepening and economic growth.

Those results are in line with Acemoglu et al. (2001, 2002) who show that political institutions are key determinants of long-run economic development. Our results are also consistent with those of Mobarak (2008) who reports that democracies lead to more rapid growth through the volatility channel. It is important to reiterate that our results hold when controlling for variables such as economic diversification and financial development, which are potentially important factors mitigating volatility.

### **3.3. Saving**

The results reported above suggest that commodity price volatility may have improved economic performance in democracies but not in autocracies. To scrutinize and interpret our results, we now systematically investigate the impact of commodity price volatility on saving behavior in commodity-exporting countries.

Table 3 presents the results of our estimates of saving regressions. On average, we find that

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<sup>15</sup> Benhabib and Spiegel (2000) report similar findings.

commodity price volatility has a positive and economically significant effect on the saving rate as shown in column (1). Using results from column (1), we find that an increase in volatility by one standard deviation leads to an increase of saving by about a third of a standard deviation. However, the coefficient associated with volatility is no longer statistically significant when we do not control for changes in our commodity price index.

Table 3. Commodity Price Volatility and the Saving Rate

	All Countries			Autocracies			Democracies		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lagged Saving	0.572*** (0.0687)	0.382*** (0.0642)	0.449*** (0.0656)	0.300*** (0.0874)	0.380*** (0.0807)	0.390*** (0.0906)	0.673*** (0.0864)	0.440*** (0.0985)	0.506*** (0.104)
Volatility	19.60 (17.48)		48.48*** (18.49)	-52.51** (25.06)		3.912 (32.01)	38.61** (18.40)		47.15*** (17.57)
$\Delta \log$ Commodity Price Index		2,270*** (299.4)	2,381*** (387.5)		2,312*** (289.5)	2,013*** (439.7)	1,438** (727.2)		2,025*** (708.3)
Credit	0.113** (0.0447)	-0.217*** (0.0526)	-0.213*** (0.0629)	0.0762 (0.104)	-0.373*** (0.0903)	-0.317*** (0.106)	0.0151 (0.0340)	-0.0802 (0.0688)	-0.142** (0.0650)
Number of observations	623	623	623	238	238	238	384	384	384
Number of countries	157	157	157	67	67	67	89	89	89

Note: The dependent variable is the saving rate. The method of estimation is system-GMM (Blundell and Bond, 1998). Standard errors are shown in parentheses below the point estimates.  
\*Significantly different from zero at 90 percent confidence, \*\* 95 percent confidence, \*\*\* 99 percent confidence. Fixed effects are included but not reported.

We also find, throughout columns (2) to (9), that changes in commodity prices encourage saving. This result suggests that an increase in revenue originating from commodity exports leads to increased saving across the spectrum of political institutions. However, our quantification exercise indicates that the response of saving to an increase in commodity prices is twice as large in democracies as in autocracies.<sup>16</sup> This result suggests that more accountable governments save effectively more than autocracies that tend to squander revenues derived from the exploitation of natural resources. Indeed, Gelb (1988) provides anecdotal evidence that governments in commodity-exporting countries often embark on large investment projects following commodity price booms. He argues that those investment projects were plagued by inefficiencies and also contributed to resource misallocation.

<sup>16</sup> While the coefficients on volatility in columns (6) and (9) and the standard deviation in commodity price index are quite close, the standard deviation associated with saving is twice as high in autocracies as in democracies. It follows that the effect of commodity price changes is twice as high in democracies as in autocracies.

Further, we find that in autocracies more volatility translates into a statistically significant decrease in saving, as shown in column (4). The coefficient associated with volatility becomes positive when controlling for changes in our commodity price index but is not statistically significant. In contrast, in democracies more volatility leads to a statistically and economically significant increase in saving as shown in columns (7) and (9). Using estimates from column (9) we find that an increase by one standard deviation in volatility in democracies increases the saving rate by two fifths of a standard deviation. This result again suggests that only governments which are subject to the scrutiny of the public as is the case in democracies save more when faced by higher volatility. Indeed, more accountable governments choose to build a buffer stock to effectively hedge against the vagaries of international commodity markets.<sup>17</sup> Moreover, governments in democracies are less prone to and less tolerant of rent seeking and, therefore, are likely to spend their revenues more effectively, yielding higher saving rates and higher rates of long-run economic growth. These results are consistent with the political economy literature which has stressed the importance of political institutions for better policy outcomes (see, e.g., Persson, 2002).

#### 4. Robustness Checks

To test whether our results are robust to the removal of outliers, observations with excessively high leverage were excluded from the sample. Specifically, all observations with  $DFBETA_{i,j}$  statistics, where  $i$  indicates the country and  $j$  the time period, with an absolute value above a cutoff point equal to  $2/\sqrt{n}$ , where  $n$  is the number of observations in the original sample, were excluded (Davidson and MacKinnon, 1993, pp. 32-39, and Besley, Kuh and Welsch, 1980). For instance, we ended up removing 57, 13 and 27 observations from the samples used in the regressions presented in columns (1), (2) and (3) in Table 2 (these results are not reported in the tables). The results

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<sup>17</sup> The market for hedging appears to remain relatively impracticable for many commodity-exporting countries. Mexico is one of the few countries to have implemented a full hedging program using financial instruments. In that context, commodity-exporting countries are left with the sole option of building strong institutions to insulate themselves from procyclical and wasteful spending programs.

presented in Tables 2 and 3 are virtually unchanged and are robust to the use of different values for the cutoff point above which observations are dropped.

A relevant question is whether our results are robust to using the quality of economic institutions rather than political institutions. Indeed, the quality of economic institutions could be seen as an outcome of political institutions. The indicators of the quality of political institutions display a relatively high correlation with economic institutions (0.46 for the rule of law; 0.57 for corruption). Also, Melhum et al. (2006), using standard cross-sectional growth regression, provide some evidence that good economic institutions can alleviate the resource curse. To test whether economic institutions play a moderating role in shaping the effect of commodity price volatility on economic growth, we split our sample between countries with a low and high quality of economic institutions based on rule-of-law and corruption indices from Political Risk Services (2009). Because the indices reflecting economic institutions range from 0 to 6, we classify countries as featuring poor (good) institutions when the average quality of institution indicator (available from 1985 onward) is below (above) 3. We do find robust evidence that both economic institution indices moderate the effect of commodity price volatility on non-resource GDP growth (the results not reported in the tables). Also, we confirm that the saving rate increases in countries with high-quality economic institutions in the face of higher volatility. Interestingly, higher volatility leads to a statistically significant decrease in saving in countries with a high degree of corruption but not in countries with high standards of rule of law. Indeed, more volatility may, in fact, lead to lower saving as it may provide more room for discretionary policies in countries with a poor institutional framework. Those results seem to support the view that political institutions as well as economic institutions do reduce rent seeking through increased public scrutiny and, thus, lead to higher saving rates which, in turn, encourage NRGDP growth in commodity-exporting countries.



## 5. Summary and Conclusion

We examined in this paper the impact of commodity price volatility on economic growth using a panel of up to 158 countries during the period 1970-2007. To do so, we used a new data set on non-resource GDP which enabled us to avoid the “noise” introduced by the resource sector’s contribution to overall GDP. Our main finding is that increased commodity price volatility leads to a significant increase in non-resource GDP growth in democracies, but has no significant effect on growth in autocracies. We offer an explanation for this finding by documenting that increased commodity price volatility leads to a statistically significant and quantitatively large increase in net national saving in democracies while net national saving decreased significantly in autocracies. Our results apply also when we use indicators capturing the quality of economic institutions in lieu of indicators of political institutions, highlighting the importance of institutions in shaping the volatility channel of the resource curse.

If we went beyond our positive analysis of the impact of commodity price volatility on saving and economic growth presented in this paper and took a normative standpoint, one potentially important direction for further research might be to determine the optimal level of precautionary saving in the face of commodity price volatility. Carroll et al. (2009) model the incentives for the residents of a country to hold foreign assets, including the precautionary motive. The model suggests a convenient formula for the economy’s target value of assets. However, the authors do not model the decision to extract natural resources. A broader portfolio allocation strategy of a country should balance the level of natural resource reserves over time with the level of net financial assets in response to increased volatility. It, therefore, remains to integrate the resource extraction decision into a portfolio model with precautionary motive.

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